Pioneer 6-9 Mission Support

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To meet the specific scientific objectives of the Pioneer 10 and G missions, the importance of the simultaneous support of the still-active Pioneers 6–9 has increased. The Pioneer Project requires tracks during the radial- and spiral-type configurations of the Pioneer 8, 9, and 10 missions. Fields and particles data acquired by DSN will make possible the measurement of distribution gradients. This article gives the description of the radial and spiral configurations and opportunities, and the support requirements.

Since the successful launch of the *Pioneer 10* mission destined to fly by Jupiter, the importance of tracking the still-active *Pioneers 6–9* spacecraft in conjunction with *Pioneer 10* has considerably increased in order to meet some of the specific interplanetary objectives of the *Pioneer 10* and *G* missions. One of the most important aspects of the interplanetary objectives is the determination of the heliocentric radial dependence of the solar wind plasma's distribution function, the parameters of the interplanetary magnetic field, and the phenomena of solar energetic particles. Past experience has already shown that these radial gradient measurements are extremely suspect when observations are obtained only from a single spacecraft. The principal difficulties are the long-term, large-scale temporal variations of the desired measurables even over periods of many solar rotations (the Sun rotates around its axis once every 27 Earth days); thus, even long-term averaging techniques are completely inadequate in shedding light on the question of radial gradients.

Simultaneous observations by two spacecraft separated by a large heliocentric radial distance are required in order to meet these specific objectives. If one wants to determine the parameters of the solar wind and magnetic field, the two spacecraft under surveillance must be aligned on the same solar radial, and, for the case of the solar energetic particles, the two spacecraft should be aligned along approximately the same interplanetary magnetic field line or spiral. Also, there have been several radial/spiral experiments performed in the past between various *Pioneer* and *Mariner* spacecraft, but the radial separation has not been sufficiently large to clearly define the gradients. In addition, the previous experiments were performed at the time when the Sun was much more active and the interplanetary medium correspondingly much more complex than it is in the present period.

Figure 1 displays the upcoming *Pioneer* radial/spiral configurations. These opportunities are listed in Table 1.

To obtain the expected results of a radial experiment, at which the Sun and two *Pioneer* spacecraft are located on the same solar radial, two weeks of simultaneous tracking surveillance is required. During this time temporal variations and signatures can be observed, and the solar winds plasma distribution function can be determined.

The solar energetic particles are traveling on an interplanetary magnetic field line which is represented by an Archimedian spiral. However, this model of the interplanetary magnetic field has not yet been validated, and it is probable that these field lines in distances larger than one astronomical unit are following a somewhat different geometry. The spiral line-up is highly dependent on the solar wind velocity. The given epochs were calculated for an average solar wind velocity of 400 km/s. Recent measurements made by the on-board instruments of the *Pioneer 6* spacecraft indicate solar wind velocities between 400 and 600 km/s. For this reason the Project requires at least daily passes for each of these missions for a duration of four weeks.

The *Pioneer 6* mission can be tracked approximately until September, 1972, from the 26-m-diam antenna stations. *Pioneer 9* will stay within the threshold of the 26-m antennas up to the first quarter of 1974. *Pioneers 7* and *8* can operate only with the 64-m antenna at DSS 14. *Pioneer 10* will be supported continuously until July 1973 from the 26-m stations. The network plans to support the *Pioneer* radial/spiral experiments within the available resources and support constraints. It is generally possible to secure the required support from one or two of the seven available 26-m antenna stations. It is, nevertheless, very difficult to obtain the required support from the 64-m station at DSS 14 which has to support, besides the *Pioneer* spacecraft, the extended phase of the *Mariner* Mars 1971 mission and numerous high-priority radio science experiments. Figure 2 depicts flight project requirements of DSS 14 (excluding the radio science experiments). This chart shows the required passes per week. It should be noted that this station has a capability of supporting approximately seven to nine passes per week. Therefore, many of the requirements are far above the available resources.

Table 1. Radial/spiral opportunities

Missions[a]	Experiment	Epoch	Required support window
Pioneers 8 and *9*	Radial	5/21/72	For one month before and one month after epoch
Pioneers 8 and *9*	Spiral	6/21/72	For two months before and two months after epoch
Pioneers 9 and *10*	Radial	8/6/72	For one month before and one month after epoch
Pioneers 9 and *10*	Spiral	12/28/72	For two months before and two months after epoch
Pioneers 8 and *10*	Radial	10/20/72	For one month before and one month after epoch
Pioneers 8 and *10*	Spiral	5/9/73	For two months before and two months after epoch

[a]At least one daily pass is required for each mission.

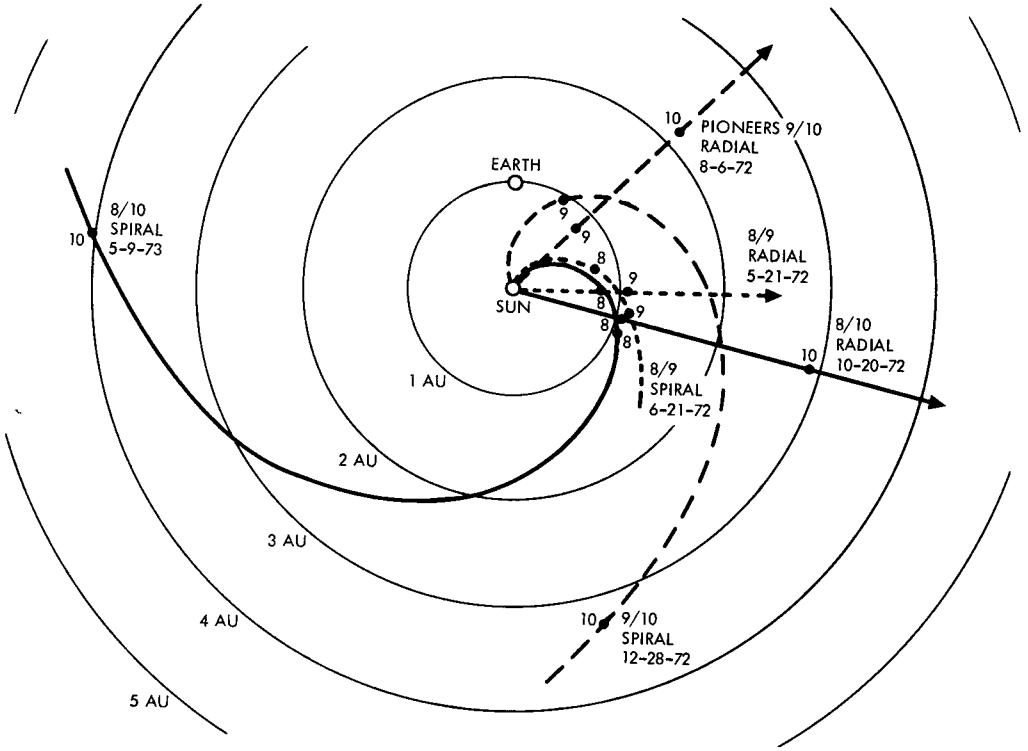

Fig. 1. *Pioneer* 8, 9 and 10 radial/spiral configurations

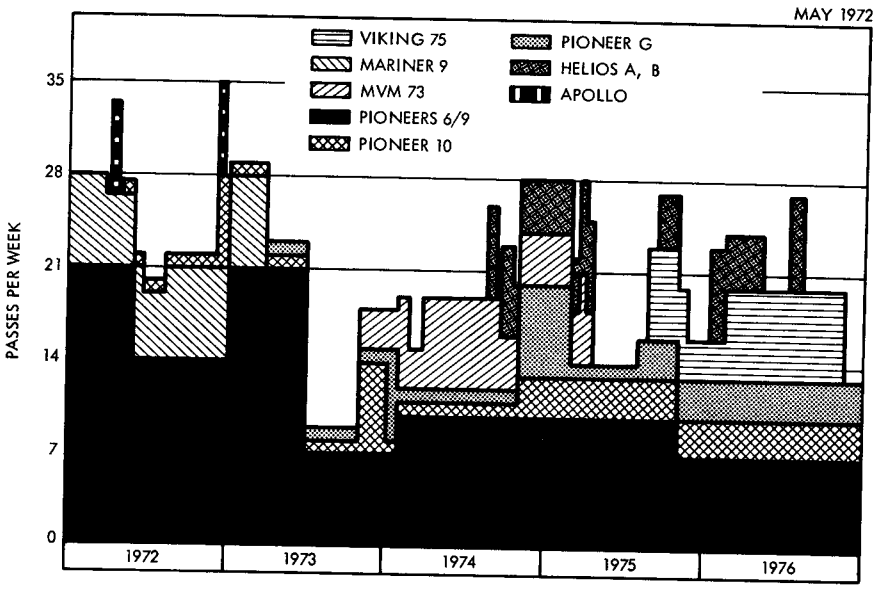

Fig. 2. DSS 14 flight project support requirements